SOIL QUALITY- AGRONOMY

Technical Note **No.2**

Conservation Crop Rotation Effects on Soil Quality

United States Department of Agriculture

Natural Resources Conservation Service

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This is the second note in a series of Soil Quality—Agronomy Technical Notes on the effects of land management on soil quality. This information is general and covers broad application. For specific cropping rotations contact your NRCS State Agronomist.

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Conservation practices such as Conservation Crop Rotation help maintain the sustainability and the efficiency of cropland over long periods of time. Conservation Crop Rotation is a systematic sequence of crops grown in combination with other crops or with grasses and legumes. There are fewer problems with weeds, insects, parasitic nematodes, diseases caused by bacteria, fungi, and viruses when using rotations compared to monocultures. When legumes are part of the rotation, nitrogen is supplied to the succeeding crop. With forage rotations, soil organic matter will increase as a result of longer rotations. Rotations can be simple, e.g., corn followed by soybeans, or very complex, e.g. tobacco with a cover crop for two years followed by corn, double cropped wheat, and soybeans using conservation tillage. Crop yields in rotation are often higher than those grown in monoculture. Practices such as conservation tillage in combination with rotations will benefit soil quality by maintaining or increasing soil organic matter. Research has shown the use of the moldboard plow reduced organic matter by an average of 256 lb/ac/yr (Reicosky et al., 1995).

Tips on Conservation Crop Rotation

- Climate and economics determine the choice of crops in rotations as well as the specific farming systems. The following principles (Magdoff, 1992) should be considered when thinking about a rotation.
- Follow a legume crop by a crop that demands high amounts of nitrogen.
- Grow a less nitrogen-demanding crop (small grains) the second year after a legume crop.
- Do not grow the same crop in consecutive years in order to decrease insects, weeds, diseases, and nematodes.
- Follow a crop with a species that is not closely related. This helps reduce insect, disease, weed, and nematode problems.
- Where applicable, use grass or legume sod in rotations or as permanent stands on sloping highly erosive soils.
- Deeply rooted crops such as alfalfa, safflower, or sunflower penetrate to depths of 5 to 6 feet and utilize nutrients and water, and leave channels from decayed roots that improve infiltration.
- To maintain organic matter, rotate high residue crops with low residue crops or use cover crops.

Erosion

Vegetative cover has a major effect on erosion. Research shows that fourth year corn, conventionally tilled at high fertility level, had erosion rates 125 times that of highly productive grass-legume sod. Cropping systems with a higher frequency of sod will reduce erosion. Growing cover crops with low residue crops and rotation of high residue crops with low residue crops are also effective erosion control practices. Some crop rotations will not reduce erosion unless other practices such as cover crops and residue management are used. Crop rotations that utilize the land more intensively such as corn, wheat and soybeans grown in two years produce larger amounts of biomass during the rotation and are more effective in reducing erosion than a continuous cropping sequence (Heath et al., 1976).

Deposition of Sediment

Increased cover from grass and or legume rotations or high residue crops combined with other conservation practices such as conservation tillage will reduce upland erosion, which in turn reduces sediment from surface runoff and wind.

Compaction

Monoculture agriculture and tillage weaken soil structural characteristics increasing susceptibility to compaction (Schnitzer, 1991). Sod base rotations with deep root systems can reduce compaction through the addition of organic matter and development of channels from decayed roots; thus improving water movement and aeration. Rotations that increase organic matter, microbial activity and aggregation of soil particles, will also increase porosity and lower bulk density.

Soil Aggregation at the Surface

Rotations that promote the increase of organic matter and microbial activity will increase aggregate stability. Caution: If residue is incorporated with tillage, benefits of increased biomass is lessened.

Infiltration

Conservation crop rotation systems that promote an increase in organic matter and an increase of aggregate stability will maintain or improve the presence of pores for infiltration (Schnitzer, 1991). Decaying roots, especially those of deep rooted crops like alfalfa and safflower, will leave channels for improved infiltration. Other conservation practices may be needed in crop rotations such as crop residue management to ensure surface protection and improve infiltration. Caution: Macropores can result in an increase of leaching of highly soluble pesticides if a heavy rain occurs within a few hours after application.

Soil Crusting

If residues are left on the soil surface and sod based rotations are included with high residue crops, the increase in organic matter, improved infiltration, and increased aggregate stability will reduce soil crusting. Caution: Monoculture and low residue cropping systems with tillage will increase the decay of organic matter and reduce aggregate stability which often results in soil crusting.

Nutrient Loss or Imbalance

One of the principles of crop rotation is to precede a nitrogen-demanding crop with a legume crop to provide nitrogen. Sod rotations with deeply rooted crops can penetrate to depths of 5 to 6 feet and cycle nutrients especially the more soluble nutrients such as nitrates. Crop rotations that promote increased biomass provide a slow release of nutrients to the root zone.

Pesticide Carryover

Where different crops are grown each year and crop rotations reduce the chance of pesticide buildup. The threat of pest tolerance to insecticides and herbicides are reduced with rotations (Reeves, 1994). Rotations increasing organic matter improve the environment for biological activity that will increase the breakdown of pesticides.

Soil Organic Matter

The amount and type of organic matter is indicative of soil productivity (Mitchell et al 1996). The types of crops grown, the amounts of roots, biomass yield, and efficiency of harvest, and the management of residues affect soil organic matter (Magdoff, 1993). High residue crops in rotation with cover crops and conservation tillage increase amounts of organic matter compared to conventional tillage and monocultureIt is practically impossible to increase organic matter where moldboard plowing is taking place (Reicosky et al., 1995). Vegetables and other low residue crop rotations will need other practices such as, cover crops to increase biomass yield.

Biological Activity

There is a direct relationship to the amount of residue and the population of soil microorganisms. Research in Oregon showed wheat-fallow systems had only 25% of the microorganisms found under pasture. When rotations are more complex and include sod crops, soil biological diversity will increase (Magdoff, 1993). Soil organisms that are active in the soil, include bacteria, fungi, actinomycetes, protozoa, yeast, algae, earthworms and insects. Numbers of soil organisms in general are proportional to organic matter concentrations in the upper 15 inches (Schnitzer, 1991). Moldboard plow tillage systems decrease earthworms and other soil organisms.

Weeds, Insects and Pathogens

Certain harmful insects and diseases can over winter in the soil. Monoculture promotes increases in insects and diseases. Different crops grown in a 2 to 3 year rotation will reduce the chances for survival of insects and diseases (Agronomy Department, Virginia Polytechnic Institute, 1959). Rotations break the life cycles of specific weeds, which adapted to narrow ecological niches associated with continuous cropping. Selective pressures on weeds, including crop competition, pathogens and pests, herbicide tolerance, fertility factors, and tillage are reduced when crop rotation is not practiced. (Reeves, 1994).

Soil Salinity

Conservation practices along with rotations that help control soil salinity include reducing summer fallow, increasing organic matter, using deeply rooted perennial forage crops, conservation tillage, and planting salt tolerant crops (Eilers et al., 1995).

Summary

Effective crop rotations are important for sustaining productivity and conserving our natural resources. In addition to erosion protection, crop rotations increase soil organic matter and improve physical properties. They also break disease, insect and, weed life cycles and improve nutrient and water usage. Conservation tillage enhances the effects of conservation rotation systems conventional tillage can often mask some of the benefits. For more information read the following references.

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